THE

[illegible]ERIAL NOCTILUCA:

OR

Some New Phœnomena,

AND A

PROCESS

OF

A Factitious Self-shining Substance.

Imparted in a Letter to a Friend, living in the Country.

By the Honourable ROBERT BOYLE, Fellow of the ROYAL SOCIETY.

LONDON.

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AN ADVERTISEMENT OF THE Publiſher to the Reader.

THE *Honourable* Author *of the following Papers, thinking it probable that the* Proceſſes *deliver'd in them, having hitherto been Publiſh'd by no man, will, as well for* that Reaſon, *as for the* Nobleneſs *of the Subject, prove not unwelcome to the Curious, in divers* Countries, *where* Engliſh *is not underſtood: He was very willing, for their ſakes,*

that this Tract *ſhould be turn'd into* Latin. *And now, to prevent the needleſs Pains of any, that may have a mind to make ſuch a* Verſion, *without having the Opportunity to conſult the* Author, *upon any doubt of his meaning, I think fit to give notice, that the* Tranſlation *is, by the* Author's *conſent, made already, and, God permitting, will quickly appear in* Publick. *Perhaps 'twill not be improper to add, that the* Reaſon, *why the following* Engliſh *Tract is Printed* in Octavo, *(as they ſpeak) is, that it may be conveniently* Bound up, *either with the* Notes, *already Publiſh'd in the ſame form about* divers Particular Qualities, *or with* thoſe other Notes *that yet remain to be Publiſh'd about* other Qualities; *to whoſe Number* Light *and* Inflammability *may be referr'd.*

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The enſuing Diſcourſe *having been written to a* Virtuoſo, *living in the* Countrey, *who has been for many years abſent from* London, *it was thought fit in the beginning of theſe* Papers *to give him ſome* Informations *about* Phoſphorus's, *and their ſeveral kinds in general, but it was not thought fit to Publiſh at the beginning of the Letter any thing of* Complement; *ſince in* that, *neither the main* Subject, *nor the* Reader, *was concern'd.*

To my very Learned Friend

Dr. J. B.

SIR,

TO gratifie your Curiosity about *Phosphorus*'s, as much as I can without indiscretion at present do, I must, in the first place, take notice to you, That though *Phosphorus*'s may well be distinguish'd into two sorts; *Those* that may be stil'd Natural, as Glow-worms, some sorts of rotten Wood and Fishes, and a few others, and *Those* that are properly Artificial: yet waving, at present, further mention of the former sort of *Bodies, that without manifest heat shine in the dark*, (which absence of sensible heat distinguishes *Phosphorus*'s from common Fire and Flame;) I shall now

confine my Diſcourſe to the latter ſort, and tell you, That as far as I have hitherto obſerv'd, thoſe factitious ſhining Bodies that do or may paſs under the name of *Phoſphorus*'s, may be reduc'd to two principal kinds, one of which may be ſubdivided into two or three, ſo that in *all* they will amount to three or four.

The *firſt* of theſe conſiſts of ſuch Bodies as ſhine only by the help of External Illuſtration, or (if you pleaſe) ſuch Bodies, as being expos'd to the beams of the Sun, or thoſe of a vigorous Flame, will retain a Lucidneſs, and continue to ſhine ſome time in the dark. Of this kind is the *Bolonian Stone*, skilfully prepar'd; and of this ſort alſo is the *Phoſphorus Hermeticus* of *Balduinus*, of whoſe *Phænomena*, but not the way of making it, the Author has given the Learned World an account. This *Phoſphorus* was therefore very welcome to divers of the Curious, becauſe the *Bolonian Stone* was for ſome years before grown very rare

rare, even in its own Countrey, *Italy*, which ſcarceneſs, an ingenious Traveller, then lately come out of thoſe Parts, told me he imputed to the death of the Perſon that us'd to prepare the Stone at *Bologna*, without having left a ſufficient account of his way of making it lucid. And the *Phoſphorus* of *Balduinus*, which, or the like, may be made (as I have tryed) both of Chaulk, and another ſubſtance, ſeem'd to me, when the Preparation ſucceeded beſt, to catch the External Light (if I may ſo ſpeak) far more readily than the *Bolonian Stone*: For I remember I have had *one*, that being freſhly made, would within about half a minute of an hour be manifeſtly excited, and as it were kindled; ſo that being preſently remov'd into a dark place, it would retain a very ſenſible Light, for ſo many times as long as it had been expos'd to the beams of the external Light; and this (if I much miſremember not) was even when that external Light was but the flame of a Candle.

But, on the other ſide, whereas I

have more than once or twice obſerv'd, with trouble, that theſe *Phoſphorus*'s could very hardly be preſerv'd for any long time, (which I was apt to impute to the action of the inſinuating Air) ſo that ſome of them in not many months, and others even in a few weeks (or perhaps days) would appear crack'd, and loſe their vertue of being excited by the beams of Light; the *Bolonian Stone*, skilfully prepar'd, would retain its vertue of being excited for a much longer time: For I remember (whatever Learned Men have deliver'd to the contrary.) I had a ſmall piece of it, which, though I kept it negligently enough in an ordinary little wooden Box, retain'd its vertue for ſeveral years after I had it, which was not till a great while after it was firſt prepar'd. What I have further obſerv'd concerning the *Phoſphorus Hermeticus*, I have not now the leiſure to acquaint you with.

But beſides this *firſt* kind of *Phoſphorus*'s, that, to be able to ſhine, muſt have

have their Faculty excited by the beams of the Sun, or *those* of some other actually shining Body: There is *another* sort, which needs not be previously illustrated by any external Lucid, and yet continues to shine far longer than the *Bolonian Stone*, or the *Phosphorus* of *Balduinus*. This, by some Learned Men has been, call'd, to discriminate it from the former, a *Noctiluca*, which, though in strictness I cannot think it as proper a name as could be wish'd, since the other *Phosphorus* will shine in the Night as well as the Day, if it be excited with the flame of a culinary Fire, or of a large Candle; *yet* since the name has been received by several, and since 'tis not easie in our Language, to express the thing clearly in one word, I shall (though for Brevity, as much as Distinction-sake) admit the use of this name, yet without forbearing sometimes to substitute for it that of a *Self-shining Substance*, which is more expressive of its nature: Of this substance, Mr. *Daniel Krafft*, a *German Chymist*,

ſhew'd His Majeſty two ſorts or degrees. To the firſt of which, I took the liberty to give the name of *Conſiſtent* (or *Gummous*) *Noctiluca*, not in that ſenſe, wherein the word is oppos'd to *Soft*, for this ſubſtance was at leaſt as yielding as Bees-Wax in Summer; but as the word *Conſiſtent* is employ'd as equivalent to *Firm*, and oppos'd to *Liquid* and *Fluid*. By reaſon alſo of its ſomewhat viſcous Texture, not very unlike that of Gum of Cherries, and ſome others newly taken from the Tree, it may be call'd, *The Gummous Noctiluca:* And, I am inform'd, that on the ſcore of its uninterrupted action, 'tis call'd by ſome in *Germany*, *The Conſtant Noctiluca*; which title it does not ill deſerve, ſince this *Phoſphorus* is much the *nobleſt* we have yet ſeen. For though there were not much of it, and though it were kept by it ſelf in a little Vial, well ſtop'd, it would, without being externally excited, inceſſantly ſhine, as he affirmed, both day and night. Yet the Light it afforded ſeem'd but little, if at all, more vivid, than

than I have ſometimes obſerved in the Liquor of Glow-worms, and ſome other *Phoſphorus*'s of Nature's producing: Nor had the Poſſeſſor enough of this ſubſtance to invite his conſent to any Trial to improve it, the quantity he had at *London*, ſcarce exceeding in Bulk the Kernel of an Almond.

Beſides this Gummous *Noctiluca*, Mr. *Krafft* had a Liquid one, that, perhaps, was made only by diſſolution of the former in Water, or ſome convenient Liquor; but the Lucidneſs of this, was not permanent like that of the other, as I have noted in another Paper: but within no very long time, eſpecially when 'twas divided into ſmaller portions, and left expos'd to the Air, would expire or vaniſh.

But beſides the Gummous and the Liquid *Noctiluca* hitherto mentioned, I know not whether we may not add a *third* kind, that we our ſelves lately prepared, which ſeems to be of a ſomewhat differing nature, both from the *Conſiſtent*, and the *Liquid Noctiluca*

newly deſcrib'd, at leaſt as far as I obſerv'd their *Phænomena*. For this of ours would not *ſhine of it ſelf*, like the *conſtant Noctiluca*, nor yet in that *manner* that the *liquid Noctiluca* did; but the bare Contact of the Air, without any external Illuſtration or Heat, would immediately produce a Light, (which might eaſily be made to laſt a good while in a well ſtop'd Veſſel:) And, which is conſiderable, the Subſtance that ſhin'd, was not the *Body of the Liquor* included in the Vial, but an Exhalation or *Effluvium* mingled with the admitted Air: for both which Reaſons, I gave it the name of *Aerial Noctiluca*.

Theſe are the ſeveral *Phoſphorus's*, that I have yet had opportunity to ſee, but, for ought I know, their variety may extend ſomewhat further, becauſe I have heard of a Paper printed in *Germany* by an ingenious man, whoſe name (if I miſtake not) is *Elſholez*, wherein particular mention is made, in an Hiſtorical way, of the *German Nocti-*

Noctiluca; But this Paper I cannot yet procure, and therefore you would do well to conſult it, if you can get it; and I am not averſe from thinking, that future Induſtry may diſcover ſome new kinds or variations of ſelf-ſhining Subſtances, that will deſerve new names, and among them, perhaps, that of *Solid Noctiluca's*.

Having ſaid thus much of the ſeveral ſorts of Artificial *Phoſphorus's*, I ſhall be very brief in ſpeaking of their Inventers, whereof I have but an imperfect information. For though I find it generally agreed, that the *Phoſphorus Hermeticus* was firſt found and publiſhed to the World, by the learned and ingenious *Balduinus*, a *German* Lawyer; yet as to the *Gummous* and *Liquid Noctiluca's*, I find the firſt invention is by ſome aſcrib'd to the abovemention'd Mr. *Krafft*, (though I remember not, that when he was *here*, he plainly aſſerted it to himſelf;) by others, attributed to an ancient Chymiſt, dwelling at *Hamburgh*, whoſe name

name (if I miſtake not) is Mr. *Brand*, and by others again, with great confidence, aſſerted to a famous *German* Chymiſt in the Court of *Saxony*, call'd *Kunckelius*. But to which of theſe ſo Noble an Invention, as that of the two *German Noctiluca's*, is juſtly due, I neither am qualified nor deſirous to judge; and therefore, without prejudicing any Man's Right, I will proceed to that, which, I preſume, is the chief thing you would know of me, namely, *An Account of the Occaſion and Steps of my own Attempt to make a Noctiluca.* Concerning *this* I ſhall give you the following Narrative, wherein, though my urgent Avocations will not (I fear) permit me to be other than immethodical, yet I ſhall not decline to mention ſome circumſtances that I know may be omitted, becauſe they will not, perhaps, be found ſo barely Hiſtorical, but that they may prove of ſome uſe to a leſs Sagacity then yours, in an enquiry into a Subject, wherein I cannot yet plainly tell you *all* you could wiſh to know, and which

which is both *New* and *Abſtruſe*, as well as *Noble*.

After the experienced Chymiſt Mr. *Daniel Krafft* had, in a Viſit that he purpoſely made me, ſhewn me and ſome of my Friends, both his *Liquid* and *Conſiſtent Phoſphorus*, being by the *Phænomena* I then obſerv'd, (and whereof the Curious have ſince had publick notice*) made certain, that there is *really* ſuch a factitious Body to be made, as would ſhine in the dark, without having been before *illuſtrated* by any lucid ſubſtance, and without being *hot* as to ſenſe: After this, I ſay, I took into conſideration by what ways it might be moſt probable, to produce, by Art, ſuch a *ſhining ſubſtance*. To ſeek for which I was both inclin'd, and hopeful to be ſomewhat aſſiſted, becauſe I had lying by me, among my yet unpubliſh'd *Notes of the Mechanical Origine of divers*

* *This Clauſe refers to one of the Philoſophical Collections publiſh'd by the ingenious* Mr. Hook, *who hath therein inſerted* verbatim *the Paper he received from* Mr. Boyle.

vers qualities, a Collection of ſome *Obſervations* & *Thoughts* concerning *light*. *Light*. And I was (alſo) the more encourag'd to attempt ſomewhat this way, becauſe having, at Mr. *Krafft's* deſire, imparted to him ſomewhat that I diſcover'd about uncommon *Mercuries*, (which I had then communicated but to one Perſon in the World) he, in requital, confeſt to me at parting, that at leaſt the principal matter of his *Phoſphorus's*, was ſomewhat that belong'd to the Body of Man. This intimation, though but very general, was therefore very welcome to me, becauſe, though I have often thought it probable, that a *ſhining ſubſtance* may, by Spagyrical Art, be obtain'd from more kinds of Bodies than one: yet deſigning, in the firſt place, to try if I could hit upon ſuch a *Phoſphorus* as I ſaw was preparable, the Advertiſement ſav'd me (for ſome time) the labor of ranging among various Bodies, and directed me to exerciſe my induſtry in a narrower compaſs. But there being divers parts of the Humane Body, that have

have been taken to task by Chymists; and, perhaps, by me as carefully, as by some others, my choice might have been distracted between the Blood, the solid Excrements, the Bones, the Urine, and the Hair, of the Humane Body; if various former Tryals and Speculations upon more than one of those Subjects, had not directed me to pitch upon *that*, which was fittest to be chosen, and of which, as I had formerly set down divers Experiments and Observations, so I had made provision of a quantity of it, and so far prepar'd it, that it wanted but little of being fit for my present purpose. But before I had made any great progress in my design, I was by divers Removes, Indispositions of Body, Law-Suits, and other Avocations, so distracted, or at least diverted, that I laid aside the prosecution of the *Phosphorus* for a long time. And when afterwards I resum'd it, though I wrought upon the right matter, yet I was diverted from the right way, by a Process that I received from Beyond Sea, as a great *Arca-*

num

num, that would certainly produce the *Noctiluca* aſpired to, for partly upon this account, but more, becauſe I ſaw that the chief Ingredient in this Proceſs, was *that* which I, with reaſon, took to be the beſt matter, I was induc'd to purſue the preſcrib'd method for ſome months, but without ſucceſs; the true matter being, as I concluded, too much either alter'd or clog'd by the additional Ingredients that were deſign'd to improve it; beſides, that the degree of Fire, though a circumſtance of the greateſt moment, was overlook'd, or not rightly preſcrib'd. However, adhering to the firſt choice I had made of a *fit* matter, I did not deſiſt to work upon it by the ways I judg'd the moſt hopeful, when a learned and ingenious Stranger, (*A. G. M. D.* Countreyman, if I miſtake not, to Mr. *Krafft*) who had newly made an Excurſion into *England*, to ſee the Countrey, having, in a Viſit he was pleas'd to make me, occaſionally diſcourſed, among other things, about the *German Noctiluca*, whereof he ſoon per-

perceiv'd I knew the true matter, and had wrought much upon it. He ſaid ſomething about the degree of Fire, that made me afterwards think, when I reflected on it, that *that* was the only thing I wanted to ſucceed in my endeavors. And there was the more reaſon to think ſo, becauſe for want of a due management of the Fire, we had divers times fail'd, of making the *Phoſphorus* of *Balduinus*, not only after we had more than once wrought upon the right matter, but after we had actually made the *Phoſphorus*. Wherefore when he left *London*, having yet ſome quantity of the matter in ſuch readineſs, that it needed but the Fire to let me ſee what I ought to think of the hint the ingenious Traveller had given me, I caus'd the tryal to be renew'd, which, proving unſucceſsful, diminiſh'd much of my ſtock of prepar'd matter, but it did not ſo diſcourage me, as to hinder me from reiterating the Attempt (without much varying it) with a good part of what remain'd. And though at this time alſo, all the care and diligence

gence that could be employ'd, did not hinder an unlucky miſcarriage, that kept the tryal from being *fully ſatisfactory*; yet being confident upon the nature of the thing, I would not believe the skilful *Laborant*, when he told me with trouble, that what I expected, was not at all produc'd: But going my ſelf to the *Laboratory*, I quickly found, that by the help of the *Air*, or ſome *Agitation* of what had paſs'd into the *Receiver*, I could, in a dark place (though it was then day) perceive ſome glimmerings of light, which, you will eaſily believe, I was not ill pleas'd to ſee. And now you have the *Hiſtory* of my purſuit of the *Liquid Phoſphorus*, that has made ſome noiſe among the Curious: But I freely confeſs, that the ſucceſs, though welcome, was not ſo full as I aim'd at, for I obtain'd no ſuch conſiſtent *Phoſphorus* as *that* whereof Mr. *Krafft* ſhew'd me, as I formerly told you, a ſmall parcel. But as I was willing to think that this defect may be imputed to the cracking of the *Retort*, before the Opera-

Operatien was quite finiſh'd, ſo I hope another Diſtillation in a more luckily choſen Veſſel, may make me amends for the newly mentioned Miſcarriage, and thereby enable me to diſcover other, and perhaps nobler *Phænomena* of our *ſhining ſubſtance*, than hitherto I have been able to obſerve. Eſpecially conſidering, that the ſame misfortune, that I hope was the principal cauſe of my miſſing the Nobleſt thing I aim'd at, the *Conſtant Noctiluca*, left me ſo little even of liquid matter, fit for my purpoſe, that I have not dared, for fear of waſting it, to try ſeveral things with it, that I preſume may be of good uſe in an enquiry into the nature of this *light*, and perhaps alſo of *light* in general. And becauſe I fear by what I have obſerv'd, that, though the Veſſel had not crackt, yet the matter diſtill'd would have afforded but a ſmall proportion of *lucid ſubſtance*, I am the more unwilling to fall upon this troubleſom work again, till, beſides other requiſites, I be provided of a competent quantity of a matter which

I fear contains but very little of the desired substance. However, I have endeavoured to make that use of our Experiment, such as it was, that though the *Noctiluca* it produc'd, be not perhaps so lucid as that of Mr. *Kraffts*, yet it may prove as luciferous as his hath hitherto been, since (as you will see hereafter) I have found a substance that needs the Air, and nothing but the Air to kindle it, and that in a moment.

In this *Narrative* I have been the more particular, that it may shew you, (what I hope may make you amends for the length of it) that an inquisitive Man should not always be deter'd by the difficulties, or even disappointments he may meet with, in prosecuting a Noble Experiment, as long as he judges himself to proceed upon good and rational grounds.

The *Uses* that may be made of *Noctiluca's*, especially of the *Consistent*, are not, in probability, all of them to be

be eaſily foreſeen and declar'd; eſpecially by me, who have not *yet* had time and ability to make thoſe improvements of ſelf-ſhining ſubſtances, that, by the aſſiſtance of the Father of Lights, I hope will, in proceſs of time, be attained. If the lucid vertue of the *Conſtant Noctiluca* could be (as I ſee not, why it may not be) conſiderably invigorated, it may prevent a great deal of danger, to which *Men of War*, and other Ships are expos'd, by the neceſſity Men often have to come into the *Gun-Room* with common flames or fire, to take out *Powder*, which has occaſion'd the blowing up of many a brave Ship. Our Light may, perhaps, be of uſe to thoſe that dive in deep waters; and alſo may very ſafely and conveniently be let down into the Sea, to what depth one pleaſes, and kept there a long time, to draw together the *Fiſhes* that are wont to reſort to the light of a Fire or Candle; as in divers parts of *Scotland* and *Ireland* is well known to the *Fiſhermen*, who get much profit by this reſort. The ſame

Self-ſhining ſubſtance which in our *Aerial Noctiluca* affords a light, that, as faint as it yet is, was able, when I wak'd in the night, to ſhew me diſtinctly enough the bigneſs and ſhape of ſome joints of my fingers, and to diſcover itſelf in the ſhape of a *Capital Letter* (of the *Alphabet*) that was cut out of a piece of black'd Paper paſted upon the Vial; this light, I ſay, may probably, (at leaſt when ſomewhat invigorated) ſuffice to ſhew the hour of the night when one wakes, (with eyes unaccuſtomed to light) if it be plac'd, inſtead of a Lamp or Candle, behind an *Index*, where the Figures employ'd to mark the Hours are cut out. It may alſo ſerve to make a guide knowable at a good diſtance off, in ſpite of tempeſtuous Winds and great Showers, and this in the darkeſt night. Divers ludicrous Experiments, very pleaſant and ſurprizing, may be made with the *Noctiluca*, by him that has enough of it. But theſe Trifles, though very pretty in their kind, I purpoſely paſs over: as alſo an uſe that may

may be of *great*, but I fear of *miſchievous*, conſequence; reſerving what I have further to ſay of the uſefulneſs of theſe *ſelf-ſhining ſubſtances*, till time ſhall give me more information, and leiſure. In the mean while I ſhall only intimate, that probably the utilities that ſo *Subtle* and *Noble* a Subſtance may be brought to afford in *Medicine*, may be more conſiderable than any of its other particular uſes; and that though our *Noctiluca* had none of theſe, yet it may be highly valuable, if it ſhall (as in all likelihood it will) be found conducive to diſcover the nature of ſo Noble a Subject, as *Light*, whoſe *Encomiums* would require more time than I can allow this writing. And perhaps they will ſeem needleſs, when I ſhall have obſerv'd, that Light was the *firſt Corporeal thing* the great *Creator* of the Univerſe was pleaſed to make; and that (as our excellent *Bacon* has well noted, to another purpoſe) he was pleas'd to alot the whole *firſt* day to the Creation of *Light* alone, without aſſociating with

it in that Honour, any other Corporeal thing.

Theſe things being premis'd, I ſhall proceed to what I chiefly intended in this *Paper*, viz. the mention of the *Obſervations* themſelves; as ſoon as, to facilitate the underſtanding of them, I ſhall have advertiſed you, that though I fear 'twill always be difficult to get out without loſs, the *ſelf-ſhining ſubſtance* rais'd by Diſtillation, yet in *our Experiment*, becauſe the Veſſels would not hold out *intire* to the laſt, we had more difficulty, than even *we* expected, to get out the *luciferous* matter, and were fain to ſave, as much as we could of it, by ſmall parcels, in diſtinct Vials. Whereof *that* which was *firſt* employ'd, though it was judg'd to have receiv'd the vigorouſeſt portion of the *ſhining* liquor; yet for a Reaſon I elſewhere intimated, (and becauſe it was not at hand, when I had firſt the opportunity to uſe it) I thought fit to make my Tryals with the *Noctiluca*, I had ſav'd in the *ſecond* Vial; ſetting aſide

ſome

ſome more faint and aqueous liquor, that was afterwards ſav'd in a *third* Vial; and a thicker ſtuff that remain'd upon the Paper, when ſome of the liquor had been put into it to be filtrated. Which Paper was kept in a *fourth* Glaſs, which, though (that it might admit the Paper and adhering luciferous ſtuff) it was wide-mouth'd, yet was it kept carefully ſtopt. Of the *Phænomena* I obſerv'd in the *ſecond* of theſe *four* Glaſſes, I ſhall, *God* permitting, at this time, give you a ſhort account; deſigning, if my haſte will give me leave, to add ſome Particulars, that I may afterwards obſerve in thoſe Portions of our *Noctiluca*, that were received in the *three* other Glaſſes.

OBSERVATIONS MADE BY Mr. Boyle, ABOUT THE AERIAL NOCTILUCA CONTAINED In His *Second* Vial.

[*Note, That this Vial was capable of holding, by our gueſs, about two Ounces of Water, but there was not in it above one ſmall ſpoonful of our Liquor.*

Obſervation I.

THE Liquor that afforded the *Aerial Noctiluca*, (for which Reaſon, and for Brevity, I often call it the

the *ſhining Liquor*) by Day-light was not near *Diaphanous*, and appear'd muddy, and of a greyiſh colour; ſomewhat like common water, rendered opacous, by having a quantity of wood-aſhes well mingled with it.

Obſerv. II.

WHen no Light appear'd in the Glaſs, we obſerv'd all the Cavity of the Vial, that reach'd from the Liquor to the Neck, to be *tranſparent*, as if there were nothing in the Glaſs, ſave a ſpoonful of dirty water at the bottom.

Obſerv. III.

BUT when the Liquor was made to ſhine vividly, then all the Cavity of the Glaſs, untaken up by the Liquor, appear'd in an external Light to be full of Fumes. And this ſeeming ſmoke, being, in the Vial that contain'd it, remov'd into a dark place, appear'd *lucid*, and ſometimes look'd like a flame

a flame that ſeem'd to be reverberated, and to be made, as it were to Circulate by the cloſe ſtop'd Neck and the Sides of the Vial. And the appearance of *whitiſh* fumes, when the Glaſs was look'd upon in an external light, was ſo uſual a Concomitant of its fitneſs to ſhine in the dark, that by looking upon the Vial by Day-light, I could readily tell, by the preſence or abſence of the *whitiſh miſt* abovementioned, whether the Matter would, in a dark place, appear *Luminous* or not.

Obſerv. IV.

WHen this Liquor had been kept for a competent time (as an hour or two, and ſometimes much leſs) in ſome dark and quiet place, or even in my Pocket; if in a darkned Room my eyes were caſt toward the place where the Vial was held, I could not perceive it to afford any light at all. And though I ſhak'd the Liquor ſtrongly enough, to give it at leaſt a moderate agitation, yet I could not diſcern,

cern, that this Motion alone, was able to bring the included Liquor, or the Vapors it may be ſuppos'd to have ſent up, to be manifeſtly *lucid.*

Obſerv. V.

BUT as ſoon as I unſtopt the *Vial* in the dark, there began to appear, as I expected, a *Light* or *Flame* in the Cavity of it. I call it *Light* or *Flame*, becauſe I dare not yet ſpeak *Dogmatically* of it; though *it* agrees with Flame in divers particulars, and though (alſo) I am not ſure that *all* Flames muſt agree in all points with *common* Flames, Experience having taught me the contrary; and particularly, that ſome Flames will burn, and be propagated in cloſe-ſtopt Veſſels. I ſhall therefore on this account, and for brevity's ſake, allow the *aggregate* of our ſhining Fumes the name of *Flame*, (which *Ariſtotle* himſelf ſomewhere ſtiles *Fumus accenſus*) but without poſitively aſſerting that it deſerves it, unleſs further *Phænomena* ſhall be found to

to intitle it thereunto. But whatever be the nature and ſubject of this *light*; the light itſelf appear'd to have, in great part, a dependance on the freſh Air, as I judg'd probable by the following *Phænomena*.

Obſerv. VI.

Firſt, I never obſerv'd the light to diſcloſe itſelf *firſt*, either *in* the liquor, or *upon* the ſurface of it; but ſtill the ſhining began at the upper part, which was firſt touch'd by the outward Air, and made a progreſs, quick indeed, but not ſo inſtantaneous, as that the eye could not follow it, from the top to the bottom of the Vial.

Obſerv. VII.

Secondly, The Contact of the Air ſeem'd neceſſary to the *propagation* as well as *production* of this flame or light: For if, having ſhaken the Vial, that the liquor might either wet the ſtopple, or communicate ſomething

to

to it, I warily bended the Cork this way and that way, ſo that only a few particles of the outward Air could inſinuate themſelves between the ſtopple and the neck of the Glaſs; there would appear on the ſides, and (perhaps) beneath the Cork, *little flames* as it were; which yet, though very vivid, were not able to propagate themſelves downwards: whereas when the Cork was quite remov'd, and acceſs was thereby allow'd to a greater quantity of Air, the *flame* or *light* (as was lately noted) preſently diffus'd itſelf through the whole Cavity of the Vial, and reach'd as low as the ſurface of the liquor.

Obſerv. VIII.

THIRDLY, Though oftentimes the light ſeem'd more vivid near the *ſurface* of the liquor, then elſewhere; (whether becauſe the *lucid* matter was *there* more denſe, I now examine not) yet when by ſtopping the Vial again, preſently after I had opened it, I endeavoured

voured to deſtroy the *flame* or *light*; I generally obſerv'd, that when it was ready to vaniſh, (which in that caſe it uſually did in no long time) it began to diſappear firſt in the bottom of the Vial, and ſeem'd to ſhrink as it were more and more upwards, till it expired at the neck of the Vial, (where it was neareſt to the Air.)

Obſerv. IX.

Fourthly, But on the other ſide, when I kept it unſtopt for ſome time, as for two or three minutes of an hour, though I afterwards ſtopt the Vial very cloſe, the Air, that had more leiſure than ordinary to inſinuate itſelf, would ſo cheriſh the flame, that the light would continue ſometimes an hour or two, and laſted once or twice no leſs than three hours.

Obſerv.

Obſerv. X.

Ifthly and laſtly, It ſeem'd that ſome *Elaſtical* Particles of the included Air, or ſome Subſtance that concur'd to the maintenance of the Flame, was waſted, or depraved and weakned, by being pen't up in the Vial with the *Emanations* of the Liquor; ſince, when the Vial had been kept ſtopt a competent time, and its Cavity appear'd tranſparent in the outward light; if I cautiouſly took out the ſtopple, the external Air ſeem'd manifeſtly to ruſh in, as if the *ſpringyneſs* of the internal had been notably debilitated by the operation of the Flame, upon the Matter with which it was kept impriſoned.

Some of theſe *Phœnomena* eaſily brought into my mind ſome of *thoſe* of an odd *Experiment*, that I formerly imparted to the Curious. In which Experiment I obſerv'd (among other things) that the *Spirit* of *Urine*, impregnated with *Copper*, after the manner

ner there preſcrib'd, would continue limpid and colourleſs, as long as the Vial, that contained it, was kept cloſe ſtopt. But when once the Air came to touch the ſurface of it, it would (ſometimes in leſs than a minute of an hour) be ſo affected thereby, that in a very ſhort time (for 'twas often within ſome minutes) the Liquor would become of a *tranſparent Sky-colour*; and afterwards, the Vial being well ſtopt, and kept in a quiet place, would by degrees grow *diaphanous*, and the Air included with it was wont to have its *ſpring* weakned. And as the change of colour was firſt produced at the ſurface, where the Liquor and Air touched one another, and was afterwards thence propagated downwards; ſo when this *Cæruleous Colour* began to diſappear, the Liquor manifeſtly became limpid firſt *at* and *near* the bottom, that is, the part which is remoteſt from the ſuperior Air.

But to return to our *Noctiluca*, the *Five Phænomena* laſt recited, and ſome

others, ſeem to favor the conjecture or ſuſpicion I lately propos'd, *about the intereſt of the Air in our unburning flame.* And to examine that ſuſpicion, I thought it leſs proper to make the foregoing Tryals with a more *vigorous Noctiluca*, then in a ſubſtance, wherein, as in that we have hitherto employ'd, the diſpoſition to be kindled, or excited to ſhine, was but *faint*; ſo that being, as long as it remain'd, unexcited, *opacous* and *dark*, the abſolute, or almoſt abſolute, neceſſity of the concurrence of Air to the actual ſhining (that conſtantly enſu'd upon its Contact) of the diſpos'd matter, ſeem'd manifeſt enough.

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DIGRESSION.

BUT to *what*, this concurrence or efficacy of the Air ought to be aſcrib'd, is a Problem that ſeem'd to me ſo difficult, that my thoughts were put upon ſeveral conjectures for ſo much as a tolerable ſolution of it; for a taſte of which, I ſhall venture to offer to you *one* or *two* of thoſe that leaſt diſpleaſe me.

I thought it not improbable that the admitted Air, either by ſome ſubtle Salt that it contain'd, or upon ſome ſuch account, excited in the fumes, it mingled with, a kind of *Fermentation*, or (if you pleaſe) a *Commotion*, by which means the matter acquired ſo briſk an agitation, as to propagate the

motion to the eye, and *there* make an impreſſion, the ſenſe whereof we call *Light:* though it ſeem'd alſo not unlikely, that ſome of the particles of the *ſuperveneing Air* may ſo aſſociate themſelves with thoſe *congruous* ones, they met with in the cavity of the Vial, that, by that Coalition, Corpuſcles were produc'd, fitted to be, by the ſubtle Ætherial matter, that abounds in the pores of the Air, ſo pervaded and briskly agitated, as to produce *light.* And it was not *new* to me, that the Air ſhould aſſociate itſelf with inviſible Exhalations, and concur with them to make new Concretions: ſince I have ſeveral times prepar'd a volatile ſulphureous liquor, red as a *Ruby*, which, when the Vial has been kept cloſe for ſome time, ſuffers the empty cavity of the veſſel to be *tranſparent*; but upon the unſtopping it, and giving acceſs to the outward Air, it appears preſently full of *white fumes*, more *opacous* than a miſt. And ſomething like *this*, though in an inferior degree, may be obſerv'd when we unſtop Glaſſes that are but partly

partly full of *Spirit* of *Salt*, or *Aqua Fortis*, provided those liquors be rectified as much, and no more, then is fit. For the contact of the Air will presently make the *former* manifestly afford *white* fumes, and the *latter* sometimes *red* ones, and sometimes otherways coloured. But if I durst mention, what my love to Mankind has oblig'd me to conceal, even from my neareſt Friends, I could give an instance of a strange power of the Air to excite a vehement Motion in fitly dispos'd Matter, though it be of a consistence far more unlikely to be thus agitated, than the *fluid* substances of our *Phosphorus*: since I experimentally know a Body, dry, and solid enough to be pulverable, that barely by the contact of the common Air, will, even when it is actually cold, in very few minutes have its parts brought to such a degree of agitation, that its heat is little less intense than *that* of some actually ignited Bodies, and may, if I please, by the further action of the Air, be brought to afford some *light* also.

But againſt this conjecture *about the cauſe of the Air's concurrence to the ſhining of our Noctiluca*, there came into my mind, among other things, a ſtrong Objection, that may be drawn from the *Conſtant Noctiluca* formerly mention'd to have been ſhewn by Mr. *Krafft*, in which the lucidneſs was conſtant, though the Vial that contain'd it, was kept ſtopt. In anſwer to this, I thought it might be ſaid, that the Particles of the *lucid* ſubſtance, being in great numbers crowded together into a little room, theſe concentrated Particles may be ſuppos'd to have been brought to ſuch a ſtate, that they needed not the renewed aſſiſtance of the outward Air, to continue ſhining; either becauſe their inteſtine motions were brisk enough to diſcuſs the minute parts of the matter, wherewith they were aſſociated, and ſo from time to time to generate or extricate, & ſupply themſelves with as many ſmall Aerial Particles, as were neceſſary to keep the maſs they belong'd to, *luminous*. Which conjecture may be illuſtrated by obſerving,

ſerving, that though our common culinary flames are preſently extinguiſh'd, unleſs they be cheriſh'd with freſh Air, yet I elſewhere recite an Experiment, of a Compoſition, which is ſo fitted to generate as much Air, as it needs, that I have ſeveral times found, that it may be kindled, and made to flame away, even *in vacuo Boyleano*, (as they call that made by our *Air-pump*.)

Other things may be alledg'd both *for* and *againſt* the propos'd conjecture, about the account on which the *Air* concurs to the light of our liquid *Noctiluca*; but, I hope, it will not be impertinent to add, that perhaps the concurrence of the Air may be *conſiderable* to both the *Phoſphorus's*, the *fluid* and the *conſiſtent*, but the external Air be *neceſſary* only to the former: becauſe in the latter, the *luciferous* Particles may have acquired ſuch a texture, as that of rotten wood, or rather of whitings, or the liquor of glow-worms, taken out after they are dead. For in

that ſtate (whatever others have written) I have kept that Juice *luminous* for very many hours, (not to ſay ſome dayes;) and 'tis conceivable enough, that in the *Conſiſtent Noctiluca*, by reaſon of the great numerouſneſs and extreme minuteneſs of the parts, and the unctuouſneſs or viſcoſity, or in a word, tenacity of them, the maſs they make up, is much leſs diſſipable than *that*, wherein the ſhining vertue of rotten wood, or the juice of dead glow-worms reſides. This conjecture may be confirm'd, by obſerving as a thing very analogous to our *Phœnomena*, that I have found ſome lights in putrid Bodies to be ſo faint, that they would, like that of our fluid *Noctiluca*, (but far more quickly) diſappear, when they were totally depriv'd of Air, as I ſeveral times found in parcels of rotten wood. And on the contrary, others had ſo vigorous or tenacious a light or flame, that, like the ſplendor of the conſtant *Noctiluca*, it would continue (though perhaps not in its full luſtre) when the outward Air was in our

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Pneumatick Engine, diligently drawn off from it. And on this occaſion I call to mind another Experiment, which ſeems yet more analogous, than any hitherto alledg'd, to our preſent production of *flame* or *light*. For having purpoſely kept certain Fiſh in a Glaſs, freed from Air, till I concluded it had lay'n longer than was neceſſary to bring it to that degree of Putrefaction, which was wont to make ſuch Fiſh, at that time of the year, to *ſhine*, I could not perceive in the Cavity of the Glaſs the leaſt glimpſe of light: and preſently after I had let in the outward Air, it did (according to my expectation) as it were, kindle a *flame*, in the proximately diſpos'd matter, or at leaſt produce in *it* a manifeſt *light*. And it may much conduce to ſhew, that the lately mentioned difference of *ſhining Bodies* may be but *gradual*, if I here obſerve, that I found by tryal, that in Bodies of the ſelf-ſame kind, as for inſtance *Glow* worms, or the ſame *ſpecies* of *Rotten*-fiſhes; if the light were but faint, the withdrawing of the Air would

would after a while make it quite disappear; and the readmission of the Air would presently make it reappear, as it happens in our *Aerial Noctiluca.* But in those individuals, wherein the *luciferous* matter was more copious and vigorous, and probably more tenacious, the absence of the external Air did somewhat lessen or impair, but not quite destroy the *light*, and so possibly it might happen in Mr. *Krafft's Consistent Noctiluca:* For though it shone without the renew'd accession of external Air, yet, that it would have been more brisk and active, if it had been assisted by such Air, I was induc'd to think, because (if I much misremember not) when once, to gratifie my curiosity, he took it out of the Vial, he usually kept it in, it did manifestly smoke and waste by the action of the Air, and produc'd considerable effects of actual heat; for this being done in the day-time, in a Room we could not darken, it could not indeed be expected, that we should discern any augmentation of light, but yet that there was

one,

one, may probably be argued from the newly mentioned things, that us'd to be its concomitants.

Such Obſervations and Reflections incline me to think, that, to ſpeak in a general way, the light of our *Noctiluca's* depends upon a peculiar and very brisk agitation of ſome minute Particles of the *ſhining matter*, in point of Bulk, Shape, and Contexture, peculiarly fitted to impel the contiguous *Æther* to the bottom of our eyes, and made me think it not improbable, that the contact of freſh external Air, might contribute to this peculiar kind of agitation in the *Gummous Noctiluca*, as an *helpful* thing, and in the *Aerial Noctiluca* as an *almoſt neceſſary* concurrent. But whether the Air concur to this effect, *as* it does itſelf excite a brisk commotion in the fumid matter, it invades, *or* whether it makes a peculiar kind of diſſipation of it, *or* whether the Air, or ſome fine ſubſtance contain'd in it, operates on this occaſion as a kind of *vital ſpirit*, ſuch as is found

found neceſſary, not only to common flame, but to *that* which is ſuppos'd to keep Animals alive; *or* whether the Corpuſcles of the admitted Air ſo combine with *thoſe*, that exhale from the groſſer liquor, as to become fit to be vehemently agitated by ſome ætherial pervading ſubſtance? whether or no, I ſay, the *agency* of the Air in our *Phænomena*, be to be refer'd to *one* or *more* of the newly mentioned things, or to ſome *other* cauſe of a peculiar and very brisk agitation, which, to ſpeak in general, ſeems to have the main ſtroak in the production of light, is left to further inquiry.

But I forget, that my intention was to ſet down *Obſervations*, not *Hypotheſis's*. And indeed the *Hiſtorical* Part, of what I had to ſay of *Phoſphorus's*, is far more uſeful and certain, than the *Conjectures* I can yet make upon it. Becauſe, though I am content to let them paſs, in regard they may afford *you* ſome hints of further ſpeculations; yet the true ſolution of the *Problem*, that

that has occaſioned this *Excurſion*, may depend ſo much upon *further* Experiments and Obſervations, that though, it is *not impoſſible*, that future *Phœnomena* may favor the propos'd conjectures, yet, it is *not very unlikely*, that I ſhall hereafter ſee cauſe to change them for ſome *Hypotheſis's*, exceedingly different from *them*. To return therefore now to our *Hiſtorical Obſervations*.

Obſerv. XI.

ALthough, in the moderately ſhaken Vial, when the light was quite vaniſht, I could not make the liquor begin to ſhine, yet when by unſtopping it a little, the flame was kindled in the Cavity of the Glaſs, then, by ſhaking it again, though it were done more faintly than before, the light ſeem'd to be manifeſtly increas'd by this agitation.

Obſerv.

Obſerv. XII.

IF I took a little of our Liquor, when 'twas in its *dark* ſtate, and laid it upon my hand, or on the ſtopple of the Vial, it would oftentimes lie there without diſcloſing any *glimpſe* of light; but if I rub'd it with my finger, or ſome other fit Body, it would then not only ſhine, but ſhine more vividly, than at beſt it us'd to do in the Vial, when the Neck of it was ſtopt; and this vivid light, whil'ſt I continued to rub the matter, it reſided in, ſeem'd from time to time to *flame* and flaſh, and did not only invade the *Noſtrils* with a ſtrong and offenſive ſmell, but viſibly ſent up ſtore of ſmoke, as if it had been ſome common culinary flame; and when, upon my ceaſing to rub the extravaſated Liquor, it ceas'd to ſhine for a pretty while, yet when I return'd to rub it again, it would again appear *luminous*: But by little & little the *lucid* vertue decay'd, till 'twas to no purpoſe to rub any more.

Obſerv.

Obſerv. XIII.

THE light of our Liquor, when excited, ſeem'd for degree much like *that*, that I obſerv'd in *ſome ſpecies* of rotten wood, that were not of the moſt vivid ſort, and when ſurrounded with Bodies of *black* colour, the reflection of its light from them was little or none. But very *white* Bodies, that were held contiguous to it, were manifeſtly illuſtrated by it, eſpecially, if the eye, having been long kept in the dark (whereby the *Pupil* uſes to be much opened, and conſequently capable of admitting more numerous beams) was made more ſuſceptible of the fainter impreſſions of light.) Inſomuch, that, when having plac'd the Vial by me, when I went to Bed, and was awake ſome time before Break of Day, I enclos'd both the Glaſs and my Head between the Sheets, the light ſeem'd to me to be very conſiderable, and to enlighten the compaſs of a foot or more in *Diameter*, and probably would

would have diffus'd itſelf further, if it had not been bounded by the ſheets, whoſe whiteneſs made the reflection of the light from them appear very *prettily*. And by the help of this light, I could eaſily perceive my Fingers, and a Ring I wore upon *one* of them; though I could not diſtinguiſh the colours of a reddiſh *Diamond*, and a couple of *Emeralds*, that were ſet in it.

Obſerv. XIV.

IN reference to the light within, the included flame in our Vial was *opacous*; for both at ſome other times, and even when I made the laſt recited *Obſervation*, I could not at all perceive my finger, when the *ſhining ſubſtance* was interpos'd betwixt it and my eye. But in reference to the external light, the flame or ſhining matter was *Diaphanous*, for even in a very faint light, by which, I think, I could ſcarce have read an ordinary Print, if I held our *luminous* Vial between the window and

and my eye, I could very plainly ſee my finger on the further ſide of the Glaſs, though, if my eye were plac'd between that and the light, the *tranſparency* would appear ſomewhat leſſened, becauſe the Cavity ſeem'd, as was formerly noted, fill'd with a kind of *whitiſh* miſt. And the like *tranſparency* and whitiſh fumes, obſervable in the ſame luminous ſteams or flame, when the Vial was look'd on, *againſt*, and *from*, the light, I found, if inſtead of the day-light, I employ'd the light of the Candle.

Obſerv. XV.

HAving the opportunity of a convenient place, and a fair Day, I ſet the Vial about Noon in a window, opened towards the *South*, and left it there expos'd to the *Sunbeams* for a conſiderable time, to try, whether *they* would, upon the account of their agitation, or ſome imaginable affinity of nature, kindle or excite the *luciferous* liquor, or its *effluvia*. But I

could not perceive that the Sun-beams had ſuch an operation, which I chiefly concluded from my not being able to perceive any whitiſh or miſt-like fumes in the Cavity of the Glaſs, for I durſt not rely upon my not perceiving any light, in the darkeſt corner of the Room, becauſe I ſuſpected, *that* might proceed from my eyes having been accuſtomed to the great light of the *then* fair day, which made it leſs ſuſceptible of impreſſions from a faint light.

Obſerv. XVI.

Acid and *Alcaliſate* Spirits being reckoned by *Chymiſts* amongſt the *moſt* ſubtle and operative ſubſtances, obtainable from mixt *Bodies* by diſtillation, I thought it very well worth while to try, by taſte, whether our *ſhining* Liquor did notably abound with Particles of either of thoſe kinds? I did not find, that the Liquor I put upon my Tongue was in the leaſt *Acid*; nor that it was ſenſibly

Alcali-

Alcaliſate, as divers Modern *Chymiſts* call ſuch *volatile* Salts and Spirits, as are afforded by *Harts-horn*, *Blood*, and ſuch like Subjects of the *Animal* Kingdom: But it ſeem'd to me to have an odd *Empyreumatical taſte*, almoſt like that of the *Spirit* of *Crude Tartar*; its *ſmell* being alſo like that, of ſome *Empyreumatical* Oil, compounded with a *ſtink*, ſomewhat like that of *ſtale* Urine. I likewiſe, for further tryal, let fall upon a piece of white Paper ſome drops of blue *Syrup* of *Violets*, to which I put a little of our Liquor, ſtirring them together with the tip of my finger; but the mixture was not thereby turn'd *green*, which it would have been by a quarter ſo much of *Spirit* of *Harts-horn*, of *Blood*, or of ſome other *Spirit*, abounding with ſalt of an urinous nature, or (as ſome love to ſpeak) with a *volatile Alcaly*. Some other *Tryals* I made, though but with very ſmall quantities of our Liquor, (becauſe I had but very little of it to ſpare) and theſe *Tryals* did, no more than the former, evince the Liquor to

belong *manifeſtly*, to the Tribe of *Acids*, or that of *Alcalies*; though perhaps, this may not be the caſe of *All* the portions of Liquor, whether more *denſe*, or more *aqueous* and dilute, that may be obtain'd by ſeveral degrees of fire, and ſome other varying circumſtances, from the matter, that affords *Noctiluca's*.

Obſerv. XVII.

Sometimes, when for curioſity's ſake, I ſhook the Vial, *ſo* that the whole Body, even to the bottom, of the Liquor, was ſpread all over the inſide of the Glaſs, I could obſerve, with pleaſure, that in many places divers little grains or corpuſcles, belonging to the *opacous* matter, that concur'd to compoſe the Liquor, ſtuck here and there to the inſide of the Vial, and that theſe, being of a *conſiſtent*, not *fluid* nature, and therefore probably more *denſe* than the thinner parts of the *Phoſphorus*, did ſhine very prettily and diſtinctly, and look'd almoſt like extreamly

treamly little ſtars, or rather radiant ſparks of fire, whoſe light was brisk enough to be diſtinctly notable, notwithſtanding *that* of the flame, that was contiguoas to them, and fill'd the Cavity of the Vial. And theſe ſhining *Corpuſcles* uſually continued their peculiar vividneſs, as long as I thought fit to look on them. Which great vigor of theirs, together with their duration, gave me hopes, that the further proſecution of what had been brought thus far, may afford us ſome, not altogether deſpicable, quantity of the *Conſiſtent Noctituca*, which, by reaſon of its denſity, tenacity, or other peculiar diſpoſition of parts, may ſhine like the *Conſtant Noctiluca* of Mr. *Krafft* formerly mentioned.

Obſerv. XVIII.

BEing deſirous to try, not *ſo much* what the Air and Agitation would do, towards the kindling or exciting (not the impriſoned Exhalation, but) the Liquor itſelf of our *Noctiluca*,

luca, (that having been partly done already*) as what Water would do to *quench* it; I thought fit to make the *Experiment*, when Time and many Trials had much impair'd its vigor. And accordingly having, in a dark place, unſtopt the Vial, and wetted the tip of my finger with the included Liquor, I could not perceive that *then* (as when it was freſhly made) it gave any *ſenſible light*. Wherefore, having rub'd the moiſtned finger againſt my other hand ſomewhat briskly, for a few moments, both the rub'd part of my hand and my finger appear'd adorn'd, each of them, with a *flame*, and though upon my dipping my finger in water (that ſtood by, ready for the purpoſe) the flame was, as it were, extinguiſht, ſince the light preſently vaniſh'd; yet, having taken out my wet finger again, and rub'd, without having previouſly dry'd it upon the other hand, as I had done before, the light, as I expected it would, did quickly re-appear.

See above, Obſerv. 12.

Beſides

Beſides the foregoing *Phænomena* of our *luciferous* Matter, that occur'd more *regularly*, there was *one* that hapned unexpected, and may perchance, (for till I have further obſerv'd, I dare not ſpeak it confidently) prove referrable to the Paper, elſewhere publiſh'd, *About ſome latent qualities of the Air.*

Obſerv. XIX.

THE *Phænomenon* was this: having one night opened the Vial ſo often mentioned, to ſhew the Production of light to a *Virtuoſo*, I quickly ſtopt it again, and put it in my Pocket, till I went to ſleep, and then laying it by me in the Bed (as I often did) when the Candles were carried out of the Room, I perceived the light, whoſe laſting, I did not expect, ſhould exceed one hour, to continue ſtill vivid enough; and then ſhaking it a little, before I compos'd my ſelf to ſleep, I laid it by, till I wak'd in the morning, and then looking upon it again, it ap-

pear'd to my eyes (that *then* for ſeveral hours had been unaccuſtomed to the light) to ſhine more vigorouſly, than it had done at firſt. And from the time I open'd it over night, till the laſt time I had occaſion to look upon it the next morning, it had continued ſhining for twelve hours; to which, whether the extraordinary warmth, that was obſerv'd *that* particular night had contributed any thing, I dare not determine, but ſhall rather add, that though this *Phœnomenon* happen'd very rarely, yet this was not the *onely* time that I obſerv'd it: For once more it occur'd to me, and *that* time the light continued about 15 hours, that I took notice of, and how much longer it might have laſted, I was hindered from obſerving. But this Circumſtance ſeem'd conſiderable, that the long duration of our *unburning* flame, hapned, after the reſt of the Tryals and Obſervations had been made; when by them, the vigor of the *luciferous* matter might reaſonably be expected to have been very much impair'd.

Obſerv.

Obſerv. XX.

WHen I had ſet down the laſt mentioned *Phœnomenon*, I thought I had concluded the *Obſervations*, peculiarly belonging to the *Aerial Noctiluca*, contain'd in our *ſecond* Vial, and hitherto treated of. But now I find my ſelf, by *Philoſophical Sincerity*, obliged to add another *Phœnomenon*, which did ſomewhat trouble, as well as ſurprize me, and it was *this*. After the foregoing *Obſervations* had been made with our *ſecond* Vial, one night that I came to open it, to ſhew one of my beſt Friends the production of *light*, I found (little to my content) that *none* at all appear'd, though I ſhook the contained liquor, and kept the Vial a pretty while unſtopt; ſo that, if he had not known me well, he might have entertain'd ſiniſter thoughts of me, till, having taken out ſome drops of the liquor, and rub'd it upon my hand, it afforded ſo vivid a *light* or *flame*, as ſatisfied him of the poſſibili-

ty

ty of a true *Noctiluca*. And ſince that time, I have not found the Vial to afford any *light*, barely upon its being unſtopt, ſo that either (in ſpight of my care) ſome Bodies unskilful curioſity has, unknown to me, ſpoil'd the liquor; or, (which is more likely) ſo little a quantity, as I had at firſt, by the many and various *Tryals* I made with it, is diſpirited and become, as it were, *effœt*; which, 'twas lucky it did not do, till the forecited *Obſervations* had been made with it. But, as in *one* of thoſe, it has been conjectured, that *one* of the chief accounts, on which the Air itſelf may concur to the ſhining of our *Noctiluca*, is, as it excited a *certain kind* of brisk motion in the parts of it, I thought fit to try, whether, though I had found the *bare ſhaking* of the Vial to be ineffectual, yet an *actual heat*, whereby the parts muſt be more vehemently and variouſly agitated, might not inable the Air to do, what otherways it could not perform; I therefore held our Vial near the fire, till it grew conſiderably warm, and then by

ſhaking

ſhaking it a little, and unſtopping it in a dark place, I perceived the exhalations, that poſſeſs'd the Cavity of the Vial, to ſhine, as formerly; but their light was ſo momentany, that it ſcarce ſooner appear'd, than vaniſh'd; and though afterwards it ſometimes appear'd, it was not vivid, nor laſted a minute of an hour, nor perhaps half ſo long; though it ſeem'd, that when *freſh* Air was then allow'd acceſs to it, its duration was thereby ſomewhat lengthned. But how long our matter will retain a diſpoſition to be excited, even by theſe means, to ſhine, experience alone can determine.

Additional

Additional

OBSERVATIONS

About the

AERIAL NOCTILUCA.

YOU may remember (Sir) that, to clear the way to the twenty foregoing *Obſervations*, I formerly told you, that we received the *luciferous* matter, obtain'd by our diſtillation, in ſeveral *ſmall Glaſſes*, as we were able to ſave it. The parcel, that was received in the *ſecond* Vial, afforded us the *Phænomena* hitherto recited; and *now* it will be fit to add to *thoſe*, ſuch as more lately occur'd, upon our conſidering the portions of *luciferous* matter, preſerv'd in the *other* Glaſſes, and ſome alſo of the like lucid ſubſtance, prepared another way. And though theſe *Obſervations*

ſervations be not ſo numerous, as the former, and be a few of them, near of kin to ſome of the others; yet I ſhall not ſcruple here to ſubjoin *them*, both becauſe moſt of them are *new*, and thoſe that are not, will ſerve to confirm and elucidate ſome of the foregoing *Obſervations*. Beſides that, 'tis not eaſie to know, what *Phænomena may*, and what *cannot*, be uſeful, to frame or verifie an *Hypotheſis* of a ſubject *new* and *ſingular*, about which we have not as yet (that I know of) any Good *Hypotheſis* ſetled.

A ſmall portion of liquor, (not much exceeding a ſpoonful) that was the *firſt*, and was judg'd the *beſt*, I ſav'd, being put into a long, and ſomewhat ſlender Cylindrical *Vial*, made of white or chryſtalline Glaſs, afforded us the enſuing *Phænomena*.

Obſerv.

Obſerv. I.

SOon after the muddy liquor (for ſuch it appear'd to the eye) was poured into the Vial, it was ſo vigorouſly luminous, (probably, in great part, from the contact and inſinuation of ſo much Air, as it met with in its tranſfuſion,) that not only it ſhone vividly, but continued to ſhine ten hours, that I took notice of, before my occaſions made me deſiſt from obſerving it.

This *Experiment* minds me of an *Objection*, which I ſhould have propoſed and anſwered at the beginning of the foregoing Paper, if I had *then* remembred to do it. For, whereas it may by ſome be thought improper for me, to call our *luciferous* matter a *ſelf-ſhining ſubſtance*, in regard that it is not *lucid*, without the concurrence or help of the Air: I anſwer, That I do, (and juſtly may) employ the word *ſelf-ſhining*, to ſignifie, that the light our matter

matter affords, is not a light *borrowed* from any external lucid, as is done by the *Bolonian* Stone, and the *Phosphorus Balduini*, but proceeds, as it were, from an *inward principle* of light. And Men scruple not, upon such an account, to reckon the flame of a Candle, and a glowing Coal, to be *self-shining Bodies*; though neither of these will be kindled, or continue to shine, without the assistance of renewed Air, no not for a *few minutes*: whereas, the newly recited *Phœnomenon* of our *Noctiluca*, shews, that, our prepar'd matter, being for a very short time, (perhaps but few minutes) impregnated by the Air, 'twill continue to shine *many hours* in a well stop'd Glass, that hinders it from being reliev'd by any supply of fresh Air.

Observ. II.

WHen I set down the *Fifth*, and some other of the foregoing *Observations*, I was not at leisure to discourse the Reasons that induced me to try for an *Aerial Noctiluca*; and

now

now alſo to ſave time, I ſhall forbear launching into ſpeculations upon that Subject, and only tell you *Hiſtorically*, that, preſuming the Matter, that would ſhine in our Cylindrical Glaſs, would not be ſo much the *Liquor itſelf*, as an aggregate of ſuch *Effluviums* of it, as, affected and excited by the Air, would become lucid; I thought fit to take particular notice, how the Air would work upon the Exhalations of this more vigorous Liquor. And accordingly, having heedfully open'd the Vial, though I very ſoon after ſtop'd it again, I obſerv'd a great Commotion to be made in the Cavity of the Glaſs, unpoſſeſs'd by the Liquor: For the now *lucid* Exhalations ſeem'd to have a nimble and almoſt circular motion, along the ſides of the Glaſs, and to make, as it were, a little whirlwind, that impetuouſly carried it round; and this renew'd *Rotation* was not only manifeſt, but laſted much longer than one would have expected: ſo great a Commotion did the Air ſeem to have produced in the *Effluviums* of the Li-

quor, and perhaps in the neighbouring parts of the Liquor itſelf. Upon the ceaſing of this unuſual motion, the light did not ceaſe, but perſevered, though I had not occaſion to obſerve, how long 'twould have laſted.

Obſerv. III.

I Will not determine, whether the vertiginous motion, mentioned in the newly recited *Obſervation*, was in part produced by what happen'd in the enſuing *Phænomenon*, which was, That having heedfully taken out the ſtopple of our Vial in a dark place, after it had for a long time ceaſed from ſhining, I obſerv'd the external Air to ruſh into the Cavity of the Glaſs with noiſe, and ſo ſwiftly, as did, I confeſs, ſurprize me: as if the preceding flame, though not ſenſibly hot, had, after the manner of culinary flames, conſiderably weakned the *ſpring* of the included Air, and ſo diſabled it to reſiſt the whole preſſure of the external Air, when, by the removal of the ſtopple

ſtopple, it was expos'd thereunto. But I will not, as I was ſaying, determine, whether this irruption of the Air, may not have contributed to the circular motion of the lucid ſteams mention'd in the foregoing obſervation? becauſe, though the affirmative ſeem a *probable* cauſe, yet I was kept from concluding it a *neceſſary* or *onely* cauſe of the turbinous motion, by my having ſome times, when no ſuch irruption of the Air had in a long time preceded, obſerved Rotations of *lucid matter* in the Cavity of the Vial: which motion therefore ſeem'd to proceed from ſome other cauſe; though (to add that by the by) this cauſe, whatever it was, produc'd but ſuch a rotation, as was leſs general, leſs nimble, and leſs laſting.

Obſerv. IV.

I Forgot to tell you in its due place, (which was before the precedent *Obſervations*) that, whil'ſt our Liquor was yet freſh and vigorous, I dipt *my*

finger in it, and moiſtned with it ſeveral places of my hands, and thoſe of ſome *Ladies*, that were deſirous to be preſent at the ſpectacle. Which done, we obſerv'd, that the places that were touched, eſpecially if they were a little rub'd, ſhone very vividly, as if actual flames, but not of a blue colour, like that of *Common Sulphur*, or of *Spirit* of *Wine*, were burning on them. And theſe flames were not at all uniform in their manner of burning, for they often ſeem'd to tremble much, and ſometimes, as it were, to blaze out with ſudden flaſhes, that were not laſting (which put me in mind of ſome of the *faculæ ſolares*.) And though it might ſeem ſtrange, that ſo ſmall a quantity of matter, that ſtuck to *this* or *that* part of the hand, ſhould afford ſo *durable* a flame; yet if that part itſelf were rub'd againſt the ſame perſons other hand, or the skin or linnen of a by-ſtander, the part new touched would ſhine, as the other continued to do: And though theſe flames were remarkable for their vividneſs, yet they con-

continued for a good while to afford the company a very pleaſing ſpectacle; and, (which was remarkable) notwithſtanding the darkneſs of the Room, it was manifeſt, that they emitted great ſtore of whitiſh ſmoke, which, or ſome other *Effluviums* from the ſame matter, imbued the neighbouring Air with a ranck and offenſive ſmell. The colour of theſe ſeeming flames, was not like the *Phoſphorus* of *Balduinus*, when 'tis very well prepar'd, and has been expos'd to a vigorous light, *red*, almoſt like a well-kindled Charcoal; but *yellow*, like *that* of the middle part of the flame of a Candle.

And notwithſtanding the Blazes and Smoke, that accompanied theſe flames, we could not perceive in them any ſenſible Heat, (that is, any confuſed agitation of parts, exceeding *that* of the parts of our Organs of touch) nor did they at all ſinge the fine Linnen of the *Ladies*, whereon ſome of them ſeem'd to burn; ſo that if we admit,

with many learned Moderns, a *flamma vitalis* in the heart, this unburning and innoxious flame may ſupply us with a far better *ſpecimen* or illuſtration thereof, than the flame of *Spirit* of *Wine* that is *ſtill* commonly employ'd, for an Example; though I have many years ago endeavor'd to rectifie the Error, by proving experimentally, that the flame of *Spirit* of *Wine* is very hot and devouring, inſomuch that I have melted *Glaſs* and *Gold* itſelf with it.

Obſerv. V.

WHen, with my finger dipt in the forementioned *Liquor*, I drew ſhort lines upon Linnen, there was left a ſhining track upon that part, over which my finger had newly paſſed, ſo that 'tis not to be denied, that one may write *lucid* Characters upon white Paper; and yet, when, having found our Liquor too *thick*, or too faintly *lucid*, to be employ'd, like Ink in an ordinary Pen; I thought fit to try, whether I could draw *lucid* Letters with

with a (middle-siz'd) *Pencil*, instead of a *Pen*, and had, for that purpose, dipt it in our Liquor; I was somewhat surpriz'd to find, that the *Characters* I had newly drawn, did not at all shine in the dark: But suspecting, that the *Pencil* might have retained, among the hairs it consisted of; the more *tenacious* and *vigorous* parts of the matter it had imbib'd, and had left only the more *aqueous* and *strengthless* parts upon the Paper; I took the *Pencil* in *one* hand, and with the *other*, compress and wreath'd a little the brushy part of it, to excite the matter, that probably was lodged there. By which means, that part of the *Pencil* was brought to look as if it were all of a *light fire*, and seem'd to burn like a small Wax Taper; but with a more blazing and pleasant flame, which some times shooting downwards, and playing about the hairs, that compos'd that part of the *Pencil*, brought into my mind those Verses of *Virgil*.

Ecce levis summo de vertice visus Iuli
Fundere lumen apex, tactuque innoxia molli
Lambere flamma comas, &c. Æneid.

But this delightful flame lasted not very long in its first vigor, but decay'd by degrees, till no more light at all was seen; after which, nevertheless, the flame would of itself break out, as if it came from the internal parts of the *Pencil*, and would shine a pretty while, and *then* seem quite to expire; after which, our light would on a sudden disclose itself again, and, when it had continued awhile in a tremulous motion, dye again in all appearance. And 'tis to be noted, that though this artificial *Ignis Lambens*, if I may so call it, did not, that I perceived, burn, or singe the slender hairs, among which it seem'd to flame, yet, as often as it appear'd, it did manifestly emit, perhaps as much, if not more smoke, than another burning *Taper* of that bigness would have done. And this vicissitude

of

of extinction and re appearance of light, lasted, till I was weary of observing it, and then, having again with my fingers compress'd, and somewhat strongly twisted the hairs of the *Pencil*, I made them, as formerly, afford a considerable light, which I thought was, whil'st I was in the very act of wreathing the hairs, accompanied with a very sensible, but momentany Heat.

Observ. VI.

BUt notwithstanding the newly recited *Heat*, 'twas in vain that I tryed, by compressing the *Pencil* first, and then rubbing it upon *Gunpowder*, well dryed, and somewhat heated, to *fire* the *Powder*. This I fail'd to do likewise, when I made the Tryal with circumstances somewhat more likely to make it succeed. Which I the less wondered at, because I remember Mr. *Krafft*, when he kindled *Gunpowder* in my Lodging, was fain to make use of his *Consistent* and *Constant Noctiluca*;

luca; and beſides, to have the *Gunpowder* prepar'd, by being made ſo hot, that 'twas almoſt ready to take fire of itſelf. Which circumſtance, I confeſs, I was glad of, as I alſo was of *my own* diſappointments, and ſome alſo of *his*, becauſe it gave me occaſion to think, that *this*, otherwiſe innocent, fire would not eaſily be perverted to the prejudice of Mankind, which, I have ſuppreſt more dangerous inventions than this, to avoid contributing to.

But upon this occaſion I muſt not pretermit what happen'd to my *Laborant*, when the diſtillation of our *luciferous* matter had been freſhly made; *namely*, that, having taken up ſome of the thicker ſubſtance with a Knife to put it into a *Vial*, and having found that *ſome* of it afterwards ſtuck to the *Blade*, he, being in ſome haſte to wipe off the adhering matter, did with his *Apron* take ſtrong hold of the *Blade* on both ſides, and then with his right hand drawing out the *Blade* nimbly, ſo that 'twas ſtrongly compreſſed in its paſ-

paſſage between the *thumb* and *fingers* of his left hand, he was much ſurprized to feel a *ſmart Heat*, and preſently looking upon that part of the *Apron*, where it had been produced, perceiv'd that it had in it *two* holes of ſome bigneſs, which he concluded muſt have been produced there by *burning*, both becauſe of the intenſe *heat* he had felt before, and becauſe 'twas a *new Apron*; which, when I had called for, and heedfully inſpected, I did, with him, impute thoſe holes to the action of the fire. Whence I judged it very probable, that the thicker and almoſt unguentous part (if I may ſo call it) of our *luciferous matter* had a great diſpoſition or propenſity to admit a very brisk agitation, ſince by an almoſt momentany, and not very vehement, motion, it was put into an agitation, that made it capable of burning *New Callico* (for of *that* the *Apron* was made.)

Obſerv.

Obſerv. VII.

SInce I uſually ſet down the *Nocturnal Obſervations* about our *Noctiluca* from time to time, as I make *them*, whil'ſt they are *freſh* in my memory, and alſo have ſent away to a Friend many of the *precedent*, before I wrote, (or made) the *ſubſequent*, you will not, I hope, think it ſtrange, either, that, not having moſt of my *materials* at once together before me, I have not *methodiz'd* them, or, that having been able to make but *gradual* diſcoveries of the Subject, I inquire into, the *things*, I write of it, ſhould now and then chance to be *coincident*, and my *expreſſions* about it ſhould ſometimes not be altogether *uniform*, but the *latter* parts ſhould agree more or leſs with the *former*, as *new* or *varying Phænomena* happen'd to require.

Upon this account, I ſhall not ſcruple to ſubjoin, what has ſince occur'd to me, about the *Phænomenon*, formerly men-

mentioned in the *Sixteenth* Obſervation; where I told you, that I could not *then* clearly find, either an *Acid* or an *Alcaliſate* Salt, to be predominant in the *luciferous* matter, I then made uſe of. But, having ſince employed *ſome* of the water, that was taken out of a *Receiver*, after it had *there* been ſomewhat impregnated with *that* matter, I thought fit to try, whether *this* water, wherein probably the ſaline Particles of our Subject might be more copiouſly diſſolved, or more active, would not diſcover itſelf to contain ſomewhat of *volatile Alcaly*. And to ſatisfie my ſelf of this, I dropt a *little* of the Liquor upon ſome *Syrup* of *Violets*, that I had put upon a piece of clean Paper, and found, I was not miſtaken, in thinking it would change the colour of the Syrup from *Blue* to *Green*; which yet it did more faintly, than the *volatile Alcalies*, (as they call them) even when they are *Phlegmatick*, are wont to do. This *Liquor* likewiſe, as I remember, made ſome conflict with *Spirit* of *Salt*, when I

firſt

first put them together, as I inferred from the commotion of the mixture, and the *Bubbles* thereby produced. Nor were these the *only* ways, by which I was induced to think, that a *volatile Alcaly*, not an *Acid Salt* or *Spirit*, was the *predominant*, if not the *only* Salt, contained in the faintly impregnated Liquor.

Observ. VIII.

BEfore I had set down *many* of the *Observations* contained in the first Paper, I was desirous to try, what would happen to our *luciferous* matter in such a *vacuum*, or, if you please, in such highly *rarified Air*, as is wont to be produced by our *Air-Pump*. But, in regard a *Glass* was to be opened in the exhausted *Receiver*, which is a difficult work to do, I was fain, for want of conveniences, to desist from my endeavors, and prosecute some other Experiments, (most of them already recited) till at length being furnished, though not with *accurate*, yet with *tolerable*

rable means of making a *Tryal*, and thinking an *imperfect* one, better than *none* at all, I took a Vial, that had ſome *luciferous* matter in it, though but ſuch, as was not apt to ſhine long at a time; and, this *Vial* being well ſtopt, I kept till the flame or light within it expir'd; then, having plac'd the Vial in a *Receiver* on our *Pneumatick* Engine, we pumpt out the Air, and *then* (not without ſome difficulty) pull'd out the Cork in a dark place, whereupon there preſently appeared ſome light in the Cavity of the Vial, which I the leſs wondered at, becauſe we found by certain Signs, that by reaſon of ſome diſadvantageous Circumſtances, we could not ſo well pump out the Air, and hinder the ingreſs of *new*, as not to leave, (though but very little, yet) enough to excite a flame, that by former experience we found to need but an inconſiderable quantity of freſh Air: But we obſerv'd, that by the commotion of the Air, occaſioned by the pumping, the flame would be as it were ventilated, and blown up, or made to ſhine more vividly. *Obſerv.*

Obſerv. IX.

BUT, not being ſatisfied by the foregoing *Experiment*, I thought fit to vary it, after the following manner. There was taken a pretty large piece of Paper, which, being well moiſtned, and partly beſmear'd with our *luciferous* matter, was thruſt into a ſomewhat wide-mouth'd Glaſs, which, being put unſtopt into a *Receiver* faſtned to our *Pneumatick* Pump, and with it kept in a dark place, did there ſhine, as I expected it would, by reaſon of the contact of the Air, *yet* contain'd in the *Receiver*. Preſently after this, the Pump was ſet awork, and we obſerv'd, as formerly, that the commotion made of the Air about the Vial, did manifeſtly enough increaſe the light for a while; and that the light ſeem'd to be leſſened, during the pauſes intercepted between theſe Commotions, both by reaſon of the Reſt, as of the Abſence of the Air. And I likewiſe took notice, That the flame that ſeemed

ed to pass from one part of the wrinkled Paper to the other, did sometimes appear to have, as it were, a palpitation, and to afford a very unequal light; and though, when the external Air was let in through the Pump into the exhausted *Receiver*, the flame seem'd to be quenched, yet I judge *that* to be only a temporary effect of the wateriſh vapors, that the Air had taken along with it in its way through the Pump; and therefore I caus'd the *Receiver* to be taken off the Engine, and *then*, the Spectators were quickly of my opinion, obſerving, that upon the free contact of the freſh outward Air, which was not like *that* laſt mentioned, depraved by moiſt vapors, the matter adhering to the Paper was quickly ſeen to ſhine again, and that more vividly, than it had done in the *Receiver*. But becauſe I ſuſpected, that this Veſſel could not at *that time*, for want of ſome conveniences, be ſo well exhauſted, as on *other* occaſions it has often been, *though*, by the *Phænomena*, hitherto recited, it ſeemed to the Spectators

that the flame was manifeſtly befriended, and the light increas'd by the Air, *yet*, I think, the *Experiment* deſerves to be repeated, when I ſhall be able to do it with more exactneſs.

Obſerv. X.

BEſides the Liquors, that afforded us the foregoing *Experiments*, we ſaved a little, (though but very little) of a ſubſtance, that was not *liquid*, but yet almoſt as *ſoft*, as mud. *This* we obtained, by pouring ſome of our liquor, taken out of the veſſels, when the diſtillation was ended, into a Glaſs Funnel, lin'd with Cap Paper, to try, whether 'twould filter. But finding, that, *that*, which paſs'd thorow, was too thin and aqueous, the filter was haſtily, and (for that reaſon) not very orderly wrapt up, and put into a Glaſs, not capacious, but yet of a moderate wideneſs at the mouth; that, both the filter might be eaſily thruſt in, and the Glaſs might be exactly enough ſtopt with a ſtrong Cork.

After

After other *Experiments* (formerly recited) had been made, I took this Glaſs, and carried it into a dark place; And though I could not perceive the leaſt glimpſe of light, yet preſuming, that it contain'd ſome of the true matter of the *Aerial Phoſphorus*, or *Noctiluca*, and conſequently Exhalations, that, having been hindered by the ſtopple to flie away, might be kindled or excited by the appulſe of the Air, I opened the Glaſs, and ſaw, (as I expected) an immediate *Apparition* of light. Which light did diſcloſe itſelf, ſometimes upon a *leſſer*, and ſometimes upon a much *greater* part of the very uneven ſurface of the included Paper, and *ſeem'd* to paſs for a great while (as long as I thought fit to ſtay to obſerve it) from one part of the Filter, and one ſide of the Glaſs, to another: I ſay, *ſeem'd*, becauſe perhaps the *Phænomenon* was produc'd by a train of eruptions of flames newly excited in ſeveral places, rather than a bare propagation of the ſame. But whatever it was, the motion, (which was pleaſant enough to be-

hold) was ſo odd and irregular, that it did not ill reſemble the motion of fire kindled by ſparks, ſtrook into a good quantity of Tinder. And this vertue of ſhining upon the ingreſs of the Air, laſted many days in the abovementioned Paper.

Obſerv. XI.

BUT there was *another* Filter, that afforded us a pleaſing variation of this *Phænomenon*; the matter wrapt up in the inſide of this Paper, being ſomewhat more copious, or better conditioned, than *that* which adhered to the *other* lately ſpoken of. We took then *this* Paper, and having unfolded it, and kept it diſplay'd in a dark place, we had the pleaſure to ſee a conſiderable number of *flames* of differing *ſizes* and *figures*, diſcloſe themſelves at the ſame time; and though *moſt* of them were vivid, yet *few* of them continued long in the ſelf-ſame place, but they ſeemed frequently to change their ſcituations among themſelves,

ſelves, as well as their figures, and extent; or elſe new flames, did inceſſantly break forth in new places, according as the exhalations, that did copiouſly and irregularly mingle with the contiguous Air, did in ſeveral places happen to be *in part*, as it were kindled by it; I ſay, *in part*, becauſe, from the *flames* themſelves, as well as the *unſhining* parts of the *Filter*, there did manifeſtly aſcend good ſtore of *ſmoke*, viſible by the light afforded by the ſhining matter: And theſe flames did not keep a *conſtant* tenour in their way of blazing, but had their tremblings, and emications, and *theſe* being uſually accompanied with changes of figure, and eruptions of light in ſeveral places at the ſame time, 'twas a very pleaſant ſight to ſee the whole *Area* or Surface of the diſplay'd Filter, look as the *Sky* ſometimes does, eſpecially in hot Countries, when the eye may perceive flaſhes of lightning break forth in ſeveral places at once: But our *Coruſcations*, being as well more numerous, as innocent, made the *Filter*

appear almoſt as variegated as *Marble* Paper: But with this advantage, that, beſides that the appearance was almoſt perpetually changing, the yellow parts were not only *coloured*, but *lucid*, and afforded thoſe, that look'd on them with me, a delightful ſpectacle, *that* laſted as long, as we thought fit to gaze at it.

Obſerv. XII.

HAving ſtrongly ſuſpected, that the agitation, duely modified, of a diſpoſed matter, was at leaſt *one* of the chief Agents in the Production of Light; I was not diſcouraged, by finding that *ſhaking* of the *Vial*, or making the contain'd Liquor more than *lukewarm*, would not produce any Apparition of Light: I was not, I ſay, thereby diſcouraged from trying, whether a more *intenſe heat*, which would communicate a brisk and various motion to a multitude of the Corpuſcles of the luciferous matter, diſperſed through the liquor, would not do,

do, what a *fainter* Agitation was not able to perform.

I thought alſo, it deſerved to be tried, *whether* a conſiderable variation of *Phænomena*, would not be conſequent to our changing the figure and capacity of the Glaſs? eſpecially, if all immediate Commerce between the Cavity of the Veſſel, and the outward Air, were carefully prevented.

In order to *both* theſe Tryals, I took ſome ſpoonfuls of Aqueous Liquor, impregnated with ſome, of the more ſoluble Portion of the *luciferous* matter; which Liquor, when it was ſetled, was tranſparent, as having but an inconſiderable quantity (which could not eaſily be ſeparated from it,) of that muddy ſubſtance, formerly more than once mentioned. And this clear Liquor, which, (perhaps becauſe of the abſence of that thicker ſubſtance) was, as it ought to be, for my purpoſe, ſo *faintly* impregnated, that it would not, with *ſhaking*, or a *mild* heat, afford *any*

light, was put into a round *Bolt-Glaſs*, whoſe Globous part was capable of holding three or four times as much, and whoſe Stem (or Pipe) was proportionable in wideneſs to it, and above a foot in length. Having carefully ſtopt this Veſſel with a Cork and ſealing Wax, 'twas in the night-time ſet in ſuch a poſture, that, by the intervention of ſand, it might be heated without breaking, (as otherwiſe it would have been in danger of doing,) and when the *Ball* was made ſo hot, that I could not well endure it in my naked hand, I ſpeedily removed the Veſſel into a dark place, and having ſhaken the Liquor, I perceived a light to break forth in the *Ball*, which preſently diffuſed itſelf thorow the whole Cavity of it, but as quickly diſappeored And ſome time after, eſpecially upon ſhaking the Glaſs, the light would break forth again, and ſoon after vaniſh; and theſe fulgurations or flaſhings of light, continued for a while to appear *now* and *then*; but were unequal, both as to their extent, vividneſs, and duration,

tion, and when the Liquor grew cold, they ceaſed quite.

Obſerv. XIII.

BUT whil'ſt *it* was yet conſiderably hot, I thought fit to try, whether by breaking the Liquor by a ſtrong concuſſion, ſome lucid ſubſtance would not be made to paſs out of the Globous into the Cylindrical part, & ſo vary the *Phænomena*. And to this purpoſe, having violently ſhaken the Liquor at ſeveral times, with Pauſes interpoſed, I perceived ſome conſiderable Portions of the lucid matter to aſcend into the Pipe; and particularly *once* I had the pleaſure to ſee a Portion of *ſhining ſubſtance*, about the bigneſs of a Filbert, or a ſmall Almond, mount directly upwards like a flame, but not very ſwiftly, from the *Globous* part of the *Glaſs*, all along the *Pipe*, till it reached the upper part of it. And at other times, ſuch flames aſcended into the Pipe, but not ſo *high*; whence *many* would have confidently infer'd a

poſitive

positive levity in flame; which yet I forbear to conclude, because I *once* (at least) obſerv'd, *one* of theſe Portions of ſhining matter, to deſcend from the higher to the lower part of the *Stem*, ſtill retaining its lucidneſs all the way.

I cannot *now* ſtay to debate, whether, the *Phænomena*, appearing in this Glaſs, may illuſtrate, or facilitate the Explication of what happens in the Production and Motions of ſome of thoſe *Meteors*, that are called *fiery*; ſuch as the *Ignis Lambens*, *Falling Stars*, Frequent *Lightnings* without Thunder, in hot Summer nights, and that wandering flame, called *Ignis Fatuus*? And whether or no, it may be ſaid, that when ſuch Bodies are generated, there happens to be a convention of Particles ſo aſſociated, that they mutually agitate each other, or are fitted to be agitated by a pervading Æthereal ſubſtance, and put into a motion, like *that*, which in the lately mentioned Portions of our *ſhining* matter, was able to produce *light*? *Obſerv.*

Obſerv. XIV.

BUT, inſtead of purſuing this Enquiry, I ſhall relate to you a *Phœnomenon*, that to *me* as well as *thoſe* I ſhew'd it to, was not a little delightful. For having, by a Concuſſion, fit for that purpoſe, as it were *ſpread* the Liquor at *once* all over the inſide of the *Globe*, and of *part* of the Stem, 'twas pleaſant to behold, how the *luciferous* matter, dividing itſelf variouſly in its paſſage downwards, adorned the whole Cavity of the Glaſs with a company of ſmall lucid Bodies, that both ſhin'd and twinkled, like ſo many little ſtars, adorning the Celeſtial Globe; and the pleaſantneſs of the ſpectacle was increaſed, by their having manifeſt *motions*, as well as true *light*. The ſlowneſs of their deſcent, in Lines, many of them very *oblique*, made this pleaſant ſight laſt the longer; and having more than once reiterated the *Experiment*, (though not ſtill with equal ſucceſs,) it afforded me ſome varied

varied *Phænomena*; which I ſhall now forbear to mention, both becauſe I want time to write, and am weary of writing, as I fear you may be of reading. And therefore I ſhall here conclude your trouble and my own, as ſoon as I ſhall have added the *two* following Particulars:

Obſerv. XV.

THE *firſt* whereof is this, That having in ſuch a *Bolt-Glaſs*, as has been lately deſcribed, given purpoſely and heedfully a certain kind of *ſtrong ſhake* to the included Liquor, when 'twas at a *due* degree of heat, (which was not *intenſe*) I obſerved, That on one ſide of the *Globous* part of the Glaſs, and above the *Body* of the Liquor, there was generated, as it were, a great *ſpark* of *lucid matter*, about the bigneſs of a Pins head; and yet hence, (as I expected) there quickly was a flame or light diffuſed through the capacity of the *Globe*, where *it* ſoon after vaniſhed. From which

which *Phænomenon*, and ſome others of affinity to it, *whether*, it may be argued, That this was a *true flame*, which from a very ſmall beginning, was increaſed by Propagation, and kindled the diſpoſed Exhalations, that it found diſperſed throughout the Cavity of the Glaſs; *or*, That the *motion* of *all* light is not neceſſarily inſtantaneous, ſince the *progreſs* of it, even in ſo ſmall a ſpace as, our *Glaſs* comprized, was diſcernable, I have not now the leiſure to debate, but muſt haſten to the *laſt* of the *two* promiſed Particulars, which is,

Obſerv. XVI.

THat, (not here to mention how I have preſerv'd a diſtill'd *luciferous* matter both *with* and *without* additaments in a *conſiſtent form*) to try, how *long* I could preſerve our *Liquor*, in a capacity to exhibit ſuch pleaſing *Phænomena*, without giving it new Air from time to time, but *only* by keeping in the ſpirituous parts: I caus'd the *Stem* to

to be Hermetically ſeal'd; preſuming, that, notwithſtanding this, I could, by a certain cautious way of holding the Veſſel, ſafely bring the included Liquor to an *heat*, ſufficiently *intenſe*, to afford us the *Phœnomena* of light. In which Suppoſition I was not miſtaken, ſince the laſt recited *Phœnomenon*, beſides ſome others, were made in this *Hermetically* ſeal'd Veſſel, in *which* the contain'd Liquor does, as I this night try'd, continue fit for that purpoſe.

OF

OF THE *Way* of preparing THE AERIAL NOCTILUCA.

THE ſeveral *Phænomena* of our *Aerial Phoſphorus* or *Noctiluca*, wherewith you have hitherto been entertain'd, have, I doubt not, raiſed in you a preſſing curioſity to know, of what matter this *ſelf-ſhining ſubſtance* was made, and *how* that *matter* was *prepar'd*, to be capable of affording it.

Though two or three years are now paſt, ſince I caus'd to be made, more than once, in my Furnaces, a *Phoſphorus*, *not unlike* that of the learned *Balduinus*, (I ſpeak thus cautiouſly, becauſe I am not ſure, what particular mat-

matter *He* employs, and I have brought more than one ſort of *Mineral* Bodies, to ſhine;) yet I forbore to divulge, what I knew, becauſe (as I declar'd to ſome curious Men, that preſs'd me to do it,) I was willing to leave *him* the liberty of publiſhing his invention. But finding he has not *yet* thought fit to impart it to the World, there appear'd the leſs cauſe to expect that the ſecret of the *Noctiluca*, which is a much more valuable thing, would be ſuddenly made publick: And therefore, without long waiting any man's leiſure, I reſolv'd to impart to the Curious, (and particularly, Sir, to your ſelf,) the knowledge of the *matter*, I wrought upon, and ſome directions *how* to manage it. And in purſuit of that reſolution, I am willing to gratifie the *Virtuoſi* with that very *proceſs* (for ſubſtance) which I ſet down, for my own remembrance, after I had the *firſt* time actually made the Aerial *Noctiluca*; and *which* I afterwards depoſited, ſeal'd up, in the hands of the very ingenious *Secretary* of the *Royal Society*,

in

in the preſence of divers Members of that illuſtrious *Company*. And though ſince that time, ſome other Tryals have enabled me to obſerve ſome *Circumſtances*, pertinent to that purpoſe; yet I thought fit to leave it it as it was, that others finding themſelves, in ſome ſort, oblig'd to employ their *own* induſtry, *their* trials may, as mine have done, produce an inſtructive diverſification of effects, in an attempt, where experience invites me to think, that various *degrees* of fire and other *circumſtances*, (and perhaps *Caſualties* too) may diverſifie the *Phœnomena*, and thereby both inrich the *yet* wanted, and deſigned *Hiſtory* of *Light*, and aſſiſt the *Speculative*, to accommodate a good *Hypotheſis* to them. Reſerving then for another time my *latter Remarks* upon the Obſervations and Proceſs, delivered in this Paper, I ſhall *now* only give you a few ſhort Advertiſements about it.

Firſt, I will not poſitively affirm, that the matter, I employ'd, is the *very*

 ſame,

ſame, than was made uſe of by the Ingenious *German Chymiſts* in their *Noctiluca*; for ſome *inquiſitive* men have very lately told me, that the *Germans* mingle *two* or *more* diſtillable materials; whereas I employ'd but *one* matter, capable of Diſtillation.

Secondly, Though all the *Twenty* foregoing *Obſervations*, and moſt of the *Ten* additional ones adnexed to them, were made with *that* ſubſtance, which I gueſs to be at leaſt the *chief*, that is employ'd by the *Germans*, (which was done for a particular reaſon, not needful to be here expreſs'd,) yet I *firſt* thought, and upon my very *firſt* tryal, found, that 'tis poſſible to make a *Noctiluca* of a *dry* and *pulverable ſubſtance*, that, for ought I can gueſs, was never employ'd by Mr. *Krafft*, or *thoſe* he had his ſecret from. And beſides this *ſecond* ſort of *Phoſphorus's*, we made a *third*, that was obtain'd from a *Body*, that never had been either a part, or an excrement, of a Humane Body, nor was mingled with any thing, that

that had been ſo. But though I found theſe *ſelf-ſhining ſubſtances* ſomewhat differing from thoſe made of the *Liquor*, hereafter to be nam'd; yet, I cannot ſtay at preſent to ſay any thing more of *them*, being content to have intimated, That *ſelf-ſhining Phoſphorus's* have been actually obtain'd from more *ſingle* Subjects, than *one*.

Thirdly, To name the *matter*, though never ſo explicitely, would not, in my opinion, have ſufficed to inform *thoſe* that would work upon *it*. For *Chymiſts* themſelves would, in all probability, work, (as hitherto, on other occaſions, they have wrought) upon the *volatile* and *ſaline*, which they preſume to be the only *ſpirituous* and *noble* parts of the Concrete, throwing away the reſt, as *uſeleſs* and *abominable*. And on this occaſion, let me add, that I was the *rather* induc'd to ſet down this *proceſs*, that we may both *obſerve*, and thankfully *acknowledge* the *wiſdom* and *bounty* of the great *Author* of *Nature*, who, for our encouragement to ſtudy

even his meaneſt works, has been pleaſed, in a *Body*, that is commonly thought *one* of the deſpicableſt of the Univerſe, to lodge ſo glorious and excellent a thing, as a *ſelf-ſhining ſubſtance*.

Fourthly, And I ſcarce doubt, but *this*, though it will be admired *now*, will be much more priz'd *hereafter*, when *it* ſhall be brought to greater perfection; and when men ſhall have diſcover'd more of its uſes, which probably will be great in *Phyſick*, and, perhaps I might add, to ſome purpoſes, that few *Chymiſts* themſelves do yet dream of.

Fifthly, One thing remains, that, to ſave ingenious men ſome labour and charge, I think fit to give early notice of; namely, that having, for tryal ſake, employ'd the *Liquor*, hereafter to be named, without previous fermentation or putrefaction; though, 'twas proceeded with after the ſame manner, with *that* whereby we obtain'd our *Noctiluca*;

Noctiluca; and though, it afforded a ſubſtance for colour and conſiſtence, not unlike our *luciferous matter*; yet I could not find, that, *that* ſubſtance would at all *ſhine*. And indeed, there are ſo many *Circumſtances*, whoſe miſtake may make the *Experiment* miſcarry, (as I have found to my trouble, even ſince the *Phoſphorus*, whoſe *Phænomena* are firſt ſet down, was made) that, though, I were not now in haſte, I ſhould be content to take time to learn better from *experience*, how to inſtruct others, before I venture to do it circumſtantially; and he that ſhall, at the *firſt* attempt, ſucceed in preparing this *Liquor*, ſhall be thought by me, either a very *skilful*, or a *lucky* Operator.

Sixthly and laſtly, That it may appear, as well by the very different *preparations*, as by the differing *Phænomena* of the *Phoſphorus Hermeticus*, and of the *Aerial Noctiluca*, that there is a great diſparity between thoſe *lucid Bodies*, I ſhall here briefly add the way

we employ'd to make either the *Phoſphorus Balduini*, or ſome *other* like *it*, (for I am not certain, what is the very way of that Learned Man) as it was practiſed in my *Furnaces*; which, in ſhort, is this.

A Diſſolution being made of fine white Chaulk in good *Spirit of Nitre*, or clean *Aqua Fortis*, it is to be filtrated thorow *Cap Paper*, and the clear Solution is to be evaporated, till there remain a *dry Subſtance*: With this white *Calx*, you are to overlay the inſide of ſome Veſſel, made of good Earth, that will endure the Fire, and that of a *round* figure, which is more convenient, than *that* of ordinary *Crucibles*; and to the matter, contain'd in this Veſſel, you are to give, for about half an hour or an hour, (according to the largeneſs of it, and other circumſtances) a due degree of Fire, which 'tis not eaſie to hit, and which ordinarily requires a conveniently ſhap'd Veſſel, whereby the *flame* or *heat* may be *reverberated*, till you perceive

ceive the matter to have acquired a diſpoſition, to retain the *light*; and *then* the earthen Veſſel, which uſually ought to be ſomewhat ſhallow, and not to exceed many inches in *Diameter*, is to have a *Cover* of fine Glaſs or Chryſtal carefully cemented on to it, to preſerve it from, its great Enemy, the Air.

What we have *obſerv'd*, in proſecuting this preparation, is not ſo *proper* to be delivered at this time, when my haſte, as well as ſome other things, make it more fit, that we ſhould forthwith return to our *Aerial Noctiluca*, of which, after the foregoing things have been premis'd, 'tis time that now there ſhould follow

THE PROCESS.

THE

Proceſs.

THere was taken a conſiderable quantity of *Humane Urine*, [becauſe the Liquor yields but a *ſmall* proportion of *luciferous matter*,] that had been, (a good part of it at leaſt) for a competent while, digeſted or putrified, before it was us'd. This *Liquor* was diſtill'd, with a moderate heat, till the *ſpirituous* parts were drawn off; after which, the ſuperfluous *moiſture* alſo was abſtracted, (or evaporated away) till the remaining ſubſtance was brought to the conſiſtence of a ſomewhat

what *thick ſyrup*, or a *thin extract*. This was well incorporated with about thrice its weight of *fine white ſand*, and the mixture was put into a ſtrong *Retort*; to which was join'd a *large Receiver*, in good part fill'd with water. Then, the *two* Veſſels being carefully luted together, a naked Fire was gradually adminiſtred, for *five* or *ſix* hours, that all, that was either *Phlegmatick*, or otherwiſe *Volatile*, might come over *firſt*. When this was done, the Fire was increas'd, and at length for *five* or *ſix* hours made (NB) which it ſhould be in this Operation) as ſtrong and intenſe, as the *Furnace* (which was not bad) was capable of giving. By this means, there came over good ſtore of *white* fumes, almoſt like *thoſe* that appear in the Diſtillation of *Oil* of *Vitriol*; and when *thoſe* fumes were paſt, and the *Receiver* grew clear, they were after a while ſucceeded by *another* ſort, that ſeem'd in the *Receiver* to give a faint *bluiſh light*, almoſt like *that* of little burning Matches, dipt in *Sul-*

phur.

phur. And last of all, the Fire being very vehement, there pass'd over *another* substance, that was judg'd more ponderous than the former, because (NB) much of it fell through the *water* to the bottom of the *Receiver*; whence being taken out, (and partly even whilst it staid *there*) it appear'd by several effects, and other *Phœnomena*, to be (as we expected) of a *luciferous nature.*

The ways I employ'd to make a *self-shining substance*, out of other matters then that expres'd in this *Process*, I must, for certain Reasons, forbear to acquaint you with, at this time.

I might, from the foregoing *Process*, take occasion to inquire, whether the *matter*, wherein the *shining* faculty chiefly resides, do not consist, not (as one would expect) of the *volatile* and *spirituous* parts of our Animal Liquor, but of its (not *absolutely*, but) *more* fixt Salt, and ponderous fœtid Oil, asso-

ciated

ciated in a peculiar manner and proportion. And from thence I might take a riſe, to propoſe my conjectures of the cauſe of the lucidneſs of our *luciferous* matter; and alſo, *both* to add ſomewhat to what, (two or three years ago) I wrote about the deſpiſed *Sapa* of Urine, in reference to ſome uncommon *Menſtruums*, and to make inquiry into other things relating to the nature of light and flame, eſpecially as found in our *Noctiluca*: Theſe things, I ſay, I might hence take occaſion to propoſe my thoughts of; but want of time, together with hopes of further diſcoveries, make me willing to defer the doing it, till I ſhall have more leiſure to frame *conjectures*, and perhaps more *Phænomena* to ground them upon. In the mean while, that, I may no further lengthen a Letter too prolix already, by Apologies for my ſelf, or Complements to you; I ſhall at preſent only beg the favor of your candid Animadverſions upon what I have written, and of thoſe ſingular *Obſervations* I hear you

you have made, *About the light of ſtinking Fiſhes*; both which, you need not doubt, will be as welcom, as I doubt not, they will prove inſtructive to,

SIR,

Your moſt Affectionate,

And moſt Humble Servant,

R. B.

Pag. 12. line 2. *dele* Light.

FINIS.